


No. 3851B

Monolithic Linear IC

# LA9210M

## Analog Signal Processor for CD Players

## OVERVIEW

The LA9210M is a bipolar analog signal processor and servocontroller IC for CD players. It is designed to be used with an LA7860/65 series digital signal processor and a minimum of external components to form a complete controller for a compact disc player.

The LA9210M operates from either a single 5 V supply, single-ended 5 V and 7 V supplies or a dual ±5 V supply and is available in 80-pin QIPs.

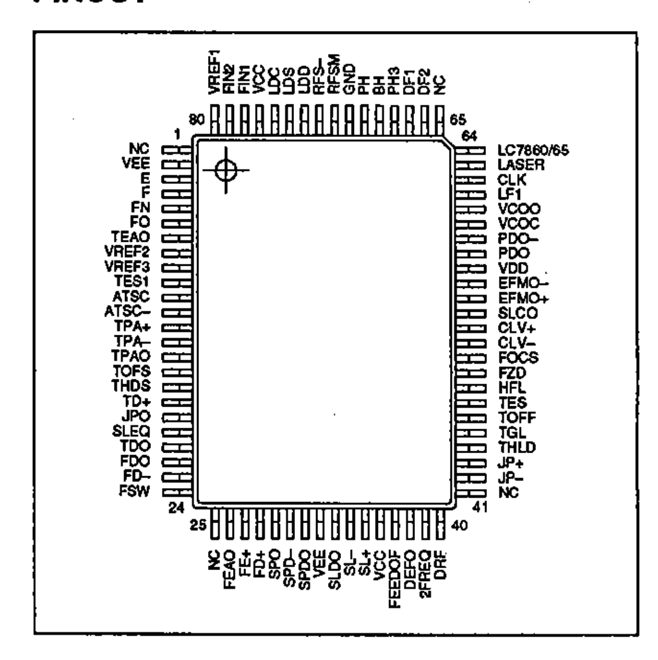
## FUNCTIONS

- RF amplifier
- Slice level control
- Voltage-controlled oscillator (VCO)
- VCO control amplifier
- Automatic laser power control (APC)
- Focus error amplifier
- Tracking error amplifier
- Track jump amplifier
- Focus servo preamplifier
- Tracking servo preamplifier
- Spindle servo preamplifier
- Sled servo preamplifier
- RF detector
- HF level detector
- Defect detector
- Shock detector
- Focus switch
- Tracking servo gain switch
- Tracking error slice comparator

## FEATURES

- Minimum of external components required
- Normal and double-speed VCO
- 5 V supply, single-ended 5 V and 7 V supplies or dual ±5 V supply
- 80-pin QIP

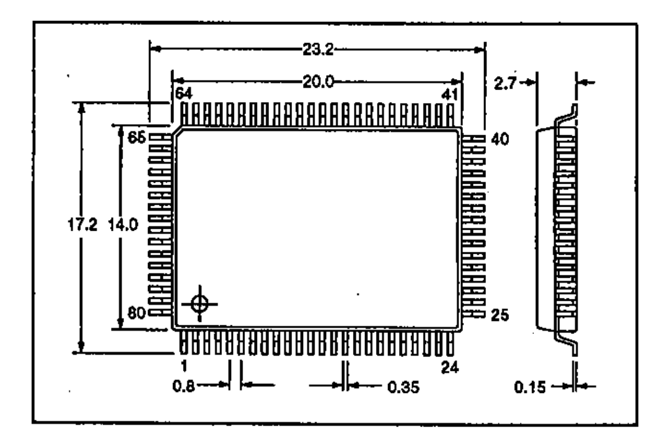
## PINOUT



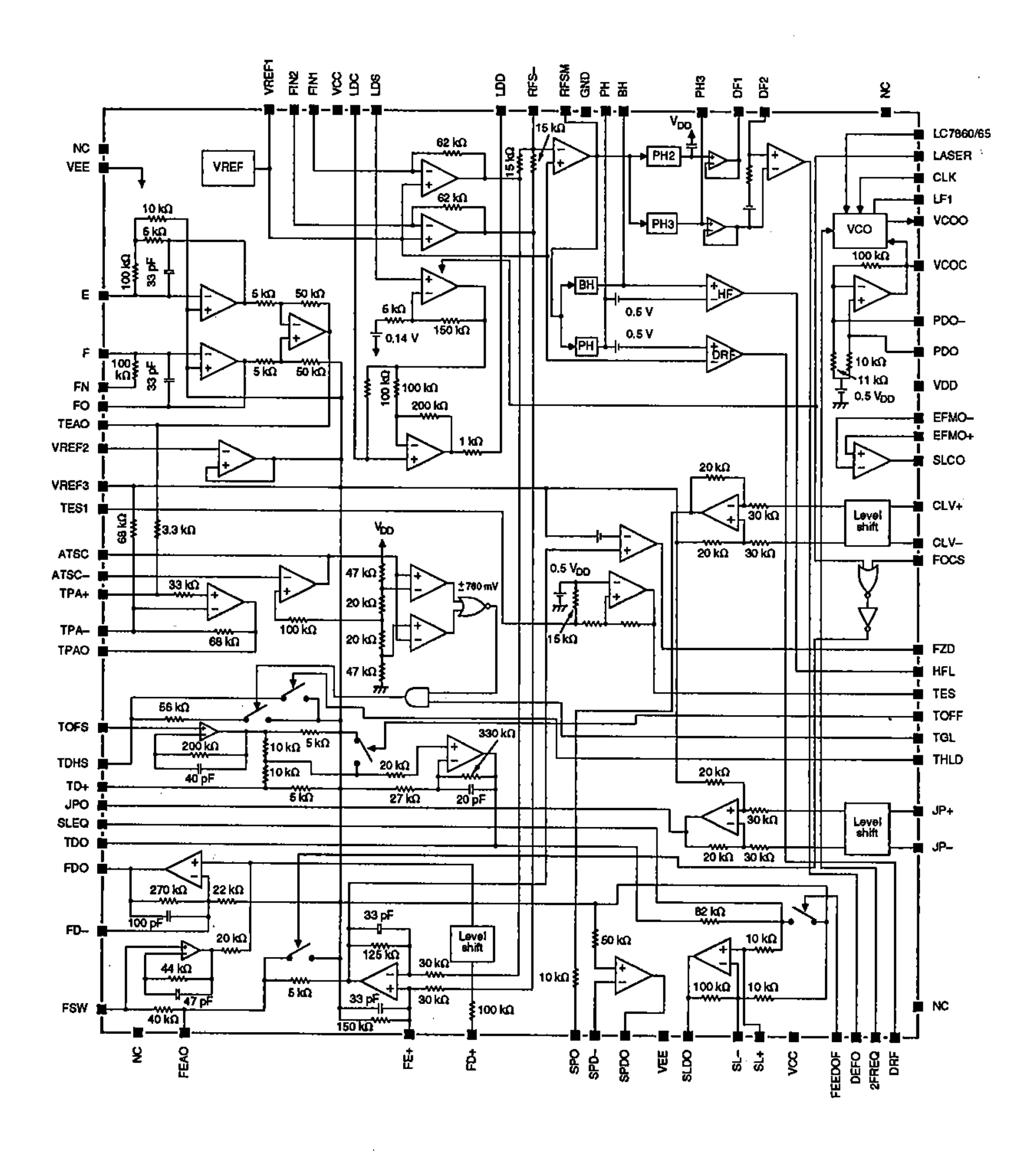

## PACKAGE DIMENSIONS

Unit: mm

**3174-QIP80E**



# SCHEMATIC DIAGRAM



# SPECIFICATIONS

## Absolute Maximum Ratings

| Parameter | Symbol | Rating | Unit |
|---|---|---|---|
| Single-ended supply voltage. See note 1. | $V_{CC}$ | 10 | V |
| | $V_{DD}$ | 7 | |
| Dual supply voltage. See note 2. | $V_{CC} - V_{EE}$ | 13 | V |
| | $V_{DD}$ | 7 | |
| TDO, FDO, SFDO and SLDO input current | $I_I$ | 1 | mA |
| TDO, FDO, SFDO and SLDO output current | $I_O$ | 1 | mA |
| Power dissipation | $P_D$ | 480 ($T_a \leq 60$ °C) | mW |
| Operating temperature range | $T_{opr}$ | –25 to 75 | °C |
| Storage temperature range | $T_{stg}$ | –40 to 150 | °C |

**Notes**

1. VEE connected to ground, $V_{CC} \geq V_{DD}$
2. VREF1, VREF2 and VREF3 connected to ground, $V_{CC} \geq V_{DD}$

## Recommended Operating Conditions

$T_a$ = 25 °C

| Parameter | Symbol | Rating | Unit |
|---|---|---|---|
| Dual supply voltage | $V_{CC}$ | 5 | V |
| | $V_{DD}$ | 5 | |
| | $V_{EE}$ | –5 | |
| Single-ended supply voltage ranges. See note 1. | $V_{CC}$ | 4.2 to 8.0 | V |
| | $V_{DD}$ | 4.2 to 6.0 | |
| Dual supply voltage ranges. See note 2. | $V_{CC}$ | 4.2 to 6.0 | V |
| | $V_{DD}$ | 4.2 to 6.0 | |
| | $V_{EE}$ | –6.0 to –4.2 | |

**Notes**

1. VEE connected to ground
2. VREF1, VREF2 and VREF3 connected to ground

## Electrical Characteristics

### Supply current

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Supply current | $I_{CC}$ | | 9 | 18 | 27 | mA |
| | $I_{DD}$ | | 10 | 15 | 20 | |
| | $I_{EE}$ | | –28 | –19 | –10 | |

## RF amplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| RF offset voltage | $V_{RF(off)}$ | FIN1 and FIN2 open, measured at RFSM | –0.65 | –0.3 | 0.05 | V |
| FIN1 and FIN2 RF voltage gain | $G_{VRF}$ | $R_g$ = 1 MΩ, $R_L$ = 33 kΩ, f = 200 kHz | –12.5 | –11.0 | –9.5 | dB |

## Focus error amplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{FE(off)}$ | FIN1 and FIN2 open, measured at FEAO | –50 | 0 | 50 | mV |
| FIN1 and FIN2 voltage gain | $G_{VFE}$ | $R_g$ = 1 MΩ, $R_L$ = 33 kΩ, f = 1 kHz | –15.0 | –11.5 | –8.0 | dB |
| FIN1 and FIN2 voltage gain differential | $\Delta G_{VFE}$ | $R_g$ = 1 MΩ, $R_L$ = 33 kΩ | –1.5 | 0 | 1.5 | dB |
| Cutoff frequency | $f_{FE(co)}$ | Measured at the half power point (–3 dB) | – | 30 | – | kHz |

## Focus drive amplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{FD(off)}$ | FEAO grounded, measured at FDO | –110 | 0 | 110 | mV |
| Voltage gain | $G_{VFD}$ | FEAO input | 21.0 | 22.5 | 24.0 | dB |
| LOW-level search voltage | $V_{FSL}$ | $V_{FOCUS}$ = 5 V, $V_{FD+}$ = 1.5 V | –3.1 | –2.0 | –0.9 | V |
| HIGH-level search voltage | $V_{FSH}$ | $V_{FOCUS}$ = 5 V, $V_{FD+}$ = 3.5 V | 0.9 | 2.0 | 3.1 | V |

### Tracking error amplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{TE(off)}$ | 5 kΩ resistor between FN and FO, 10 kΩ resistor between FN and ground, E and F open, measured at TEAO | –200 | 0 | 200 | mV |
| Voltage gain | $G_{VTE}$ | 5 kΩ resistor between FN and FO, 10 kΩ resistor between FN and ground, E and F open, f = 1 kHz | 1.0 | 4.5 | 8.0 | dB |
| Voltage gain differential | $\Delta G_{VTE}$ | 5 kΩ resistor between FN and FO, 10 kΩ resistor between FN and ground | –1 | 0 | 1 | dB |
| Cutoff frequency | $f_{TE(co)}$ | Measured at the half- power point (–3 dB) | – | 30 | – | kHz |

### Tracking error preamplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{TP(off)}$ | 5 kΩ resistor between FN and FO, 10 kΩ resistor between FN and ground, measured at TPAO | –350 | 0 | 350 | mV |
| Voltage gain | $G_{VTP}$ | 5 kΩ resistor between FN and FO, 10 kΩ resistor between FN and ground, TPA+ open, 1 MΩ resistor between E and F, f = 1 kHz | 7.0 | 10.5 | 14.0 | dB |

### Tracking detector amplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{TD(off)}$ | 200 kΩ resistor between TOFS and ground, measured at TDO | –120 | 0 | 120 | mV |
| Voltage gain | $G_{VTD}$ | 200 kΩ resistor between TOFS and ground, TOFS input, TD– open | 16.5 | 18.0 | 19.5 | dB |

## Peak hold circuit

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{PH(off)}$ | $I_{FIN1}$ = $I_{FIN2}$ = 7.3 µA, measured between PH and RFSM | –0.2 | –0.1 | 0.1 | V |

## RF detector

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| LOW-level threshold voltage | $V_{DRFL(TO)}$ | The voltage on PH at which DRF goes LOW | – | – | 0.5 | V |
| | | The voltage between PH and VREF1 at which DRF goes LOW. REF1, REF2 and REF3 open | – | – | 0.28 | |
| HIGH-level threshold voltage | $V_{DRFH(TO)}$ | The voltage on PH at which DRF goes HIGH | 1.15 | – | – | V |
| | | The voltage between PH and VREF1 at which DRF goes HIGH. REF1, REF2 and REF3 open | 0.72 | – | – | |
| LOW-level output voltage | $V_{DRF(OL)}$ | | – | 0 | 0.6 | V |
| HIGH-level output voltage | $V_{DRF(OH)}$ | | 4.0 | 4.1 | 4.6 | V |

## Focus zero-crossing detector

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| LOW-level threshold voltage | $V_{FZDL(TO)}$ | 1 MΩ FIN2 input resistor, the voltage on FEAO at which FZD goes LOW | – | – | –0.85 | V |
| HIGH-level threshold voltage | $V_{FZDH(TO)}$ | 1 MΩ FIN2 input resistor, the voltage on FEAO at which FZD goes HIGH | –0.35 | – | – | V |
| LOW-level output voltage | $V_{FZD(OL)}$ | | – | 0 | 0.6 | V |
| HIGH-level output voltage | $V_{FZD(OH)}$ | | 4.0 | 4.1 | 4.6 | V |

## Bottom hold circuit

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{BH(off)}$ | $I_{FIN1}$ = $I_{FIN2}$ = 7.3 µA, measured between BH and RFSM | –0.2 | –0.1 | 0.1 | V |

## High-frequency level comparator

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| LOW-level threshold voltage | $V_{HFL(TO)}$ | $V_{PH}$ = 0 V, the voltage on BH at which HFL goes LOW | – | – | –0.7 | V |
| HIGH-level threshold voltage | $V_{HFH(TO)}$ | $V_{PH}$ = 0 V, the voltage on BH at which HFL goes HIGH | –0.3 | – | – | V |
| LOW-level output voltage | $V_{HF(OL)}$ | | – | 0 | 0.6 | V |
| HIGH-level output voltage | $V_{HF(OH)}$ | | 4.0 | 4.1 | 4.6 | V |

## Tracking error slice comparator

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| LOW-level threshold voltage | $V_{TESL(TO)}$ | 100 kΩ TES1 input resistor, the voltage on TES1 at which TES goes LOW | 1.0 | 1.7 | 2.5 | V |
| HIGH-level threshold voltage | $V_{TESH(TO)}$ | 100 kΩ TES1 input resistor, the voltage on TES1 at which TES goes HIGH | 2.5 | 3.5 | 4.0 | V |
| LOW-level output voltage | $V_{TES(OL)}$ | | 0 | 0.2 | 1.0 | V |
| HIGH-level output voltage | $V_{TES(OH)}$ | | 4.0 | 4.1 | 4.6 | V |

## Jump pulse amplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{JP(off)}$ | Measured at JPO | –20 | 0 | 20 | mV |
| LOW-level output voltage | $V_{JP(OL)}$ | JP– = 5 V | –3.55 | –3.20 | –2.85 | V |
| HIGH-level output voltage | $V_{JP(OH)}$ | JP+ = 5 V | 2.85 | 3.20 | 3.55 | V |

## Servo pulse amplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{SP(off)}$ | Measured at SPO | –20 | 0 | 20 | mV |
| LOW-level output voltage | $V_{SP(OL)}$ | $V_{CLV-}$ = 5 V | –3.55 | –3.20 | –2.85 | V |
| HIGH-level output voltage | $V_{SP(OH)}$ | $V_{CLV+}$ = 5 V | 2.85 | 3.20 | 3.55 | V |

## Spindle drive amplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{SPD(off)}$ | 51 kΩ resistor between SPD– and SPDO, measured at SPDO | –110 | 0 | 110 | mV |
| Voltage gain | $G_{VSPD}$ | 51 kΩ resistor between SPD– and SPDO, 51 kΩ SPD– input resistor | –1.5 | 0 | 1.5 | dB |

## Sled amplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{SLD(off)}$ | SLEQ grounded, measured at SLDO | –60 | 0 | 60 | mV |
| Output voltage with gain | $V_{SLD(G)}$ | SLEQ grounded, $I_{SL+}$ = 10 µA | 1.2 | 1.9 | 2.6 | V |

## VCO control amplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Quiescent output voltage | $V_{VCOC(O)}$ | Measured at VCOC | 2.3 | 2.5 | 2.7 | V |
| Output voltage with gain | $V_{VCOC(G)}$ | $I_{PDO}$ = 10 µA | 3.15 | 3.50 | 3.85 | V |

## Slice level comparator amplifier

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Output voltage | $V_{SLC(O)}$ | 10 kΩ resistor between SLCO and EFMO–, 10 kΩ resistor between EFMO+ and 2.5 V reference | 2.4 | 2.5 | 2.6 | V |

## Focus switch

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{FSW(off)}$ | $V_{FOCS}$ = 5 V, measured at FEAO | –20 | 0 | 20 | mV |
| Focus switch OFF threshold voltage | $V_{FSW1(TO)}$ | The voltage on FOCS at which the focus switch turns OFF | – | – | 1.0 | V |
| Focus switch ON threshold voltage | $V_{FSW2(TO)}$ | The voltage on FOCS at which the focus switch turns ON | 4.0 | – | – | V |

## Tracking OFF switch

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{TFS(off)}$ | $V_{TOFF}$ = 5 V, 200 kΩ TOFS input resistance, $V_{TOFS}$ = 0.126 V | –20 | 80 | 160 | mV |
| Tracking OFF switch OFF threshold voltage | $V_{TFS1(TO)}$ | The voltage on TOFF at which the tracking OFF switch turns OFF | – | – | 1.0 | V |
| Tracking OFF switch ON threshold voltage | $V_{TFS2(TO)}$ | The voltage on TOFF at which the tracking OFF switch turns ON | 4.0 | – | – | V |

## Tracking hold switch

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{THS(off)}$ | 56 kΩ resistor between THDS and 5 V reference, $V_{THLD}$ = 5 V, measured at THDS | –60 | 0 | 60 | mV |
| Tracking hold switch OFF threshold voltage | $V_{THS1(TO)}$ | The voltage on THLD at which the tracking hold switch turns OFF | – | – | 1.0 | V |
| Tracking hold switch ON threshold voltage | $V_{THS2(TO)}$ | The voltage on THLD at which the tracking hold switch turns ON | 4.0 | – | – | V |

## Tracking servo gain switch

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Tracking gain LOW-level switch OFF threshold voltage | $V_{TGS1(TO)}$ | The voltage on TGL at which the tracking gain LOW-level switch turns OFF | – | – | 1.0 | V |
| Tracking gain LOW-level switch ON threshold voltage | $V_{TGS2(TO)}$ | The voltage on TGL at which the tracking gain LOW-level switch turns ON | 4.0 | – | – | V |

## Sled amplifier OFF switch

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Sled OFF switch OFF threshold voltage | $V_{SFS1(TO)}$ | The voltage on FEEDOF at which the sled OFF switch turns OFF | – | – | 0.5 | V |
| Sled OFF switch ON threshold voltage | $V_{SFS2(TO)}$ | The voltage on FEEDOF at which the sled OFF switch turns ON | 2.0 | – | – | V |

## Automatic laser power control circuit

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Start voltage P | $V_{APCP(S)}$ | LDC open, $V_{LDD}$ = –3 V, measured on LDS | –4.95 | –4.91 | –4.87 | V |
| End voltage P | $V_{APCP(E)}$ | LDC open, $V_{LDD}$ = 3 V, measured on LDS | –4.85 | –4.81 | –4.77 | V |
| Start voltage N | $V_{APCN(S)}$ | LDC grounded, $V_{LDD}$ = 3 V, measured on LDS | –4.93 | –4.89 | –4.85 | V |
| End voltage N | $V_{APCN(E)}$ | LDC grounded, $V_{LDD}$ = –3 V, measured on LDS | –4.87 | –4.83 | –4.79 | V |
| OFF voltage P | $V_{APCP(OFF)}$ | LDC open, $V_{LASER}$ = 5 V | 4.0 | 4.6 | 5.0 | V |
| OFF voltage N | $V_{APCN(OFF)}$ | LDC grounded, $V_{LASER}$ = 5 V | –5.0 | –4.3 | –4.0 | V |
| Automatic power control OFF threshold voltage | $V_{APC1}$ | The voltage on LASER at which the focus switch turns OFF and the automatic power control circuit turns ON | – | – | 1.0 | V |
| Automatic power control ON threshold voltage | $V_{APC2}$ | The voltage on LASER at which the focus switch turns ON and the automatic power control circuit turns OFF | 4.5 | – | – | V |

## Defect detector circuit

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Offset voltage | $V_{DF(off)}$ | $I_{FIN1}$ = $I_{FIN2}$ = 7.3 µA, 10 kΩ resistor between FEFO and ground | 0.2 | 0.4 | 0.6 | V |
| LOW-level output voltage | $V_{DF(OL)}$ | | – | 0 | 0.2 | V |
| HIGH-level output voltage | $V_{DF(OH)}$ | | 4.0 | 4.8 | 5.0 | V |

## Shock detector circuit

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Quiescent voltage | $V_{SH(OFF)}$ | Measured on ATSC | 2.3 | 2.5 | 2.7 | V |
| Detector LOW-level threshold voltage | $V_{SHCL(TO)}$ | ATSC– current (between 0 and –15 µA) at which $V_{THDS}$ = 4 V | –9.0 | –7.5 | –6.0 | µA |
| Detector HIGH-level threshold voltage | $V_{SHCH(TO)}$ | ATSC– current (between 0 and –15 µA) at which $V_{THDS}$ = 4 V | 6.0 | 7.5 | 9.0 | µA |

## Voltage-controlled oscillator

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Free-running frequency | $f_{VCO}$ | LC7860/65 grounded, $f_{CLK}$ = 4.3224 MHz, $V_{2FREQ}$ = 0 V, 160 kΩ resistor between LF1 and 5 V | 8.14 | 8.64 | 9.14 | MHz |
| | | $V_{LC7860/65}$ = 5 V, $f_{CLK}$ = 2.1609 MHz, $V_{2FREQ}$ = 0 V, 160 kΩ resistor between LF1 and 5 V | 8.14 | 8.64 | 9.14 | |
| Maximum adjustment frequency | $\Delta f_{VCO}$ | $V_{PDO}$ = 2 V, $V_{LC7860/65}$ = 5 V, $f_{CLK}$ = 2.1609 MHz, $V_{2FREQ}$ = 0 V, 160 kΩ resistor between LF1 and 5 V | 0.60 | 0.95 | – | MHz |
| Minimum adjustment frequency | $\Delta f_{VCO2}$ | $V_{PDO}$ = 3 V, $V_{LC7860/65}$ = 5 V, $f_{CLK}$ = 2.1609 MHz, $V_{2FREQ}$ = 0 V, 160 kΩ resistor between LF1 and 5 V | – | –0.95 | –0.60 | MHz |

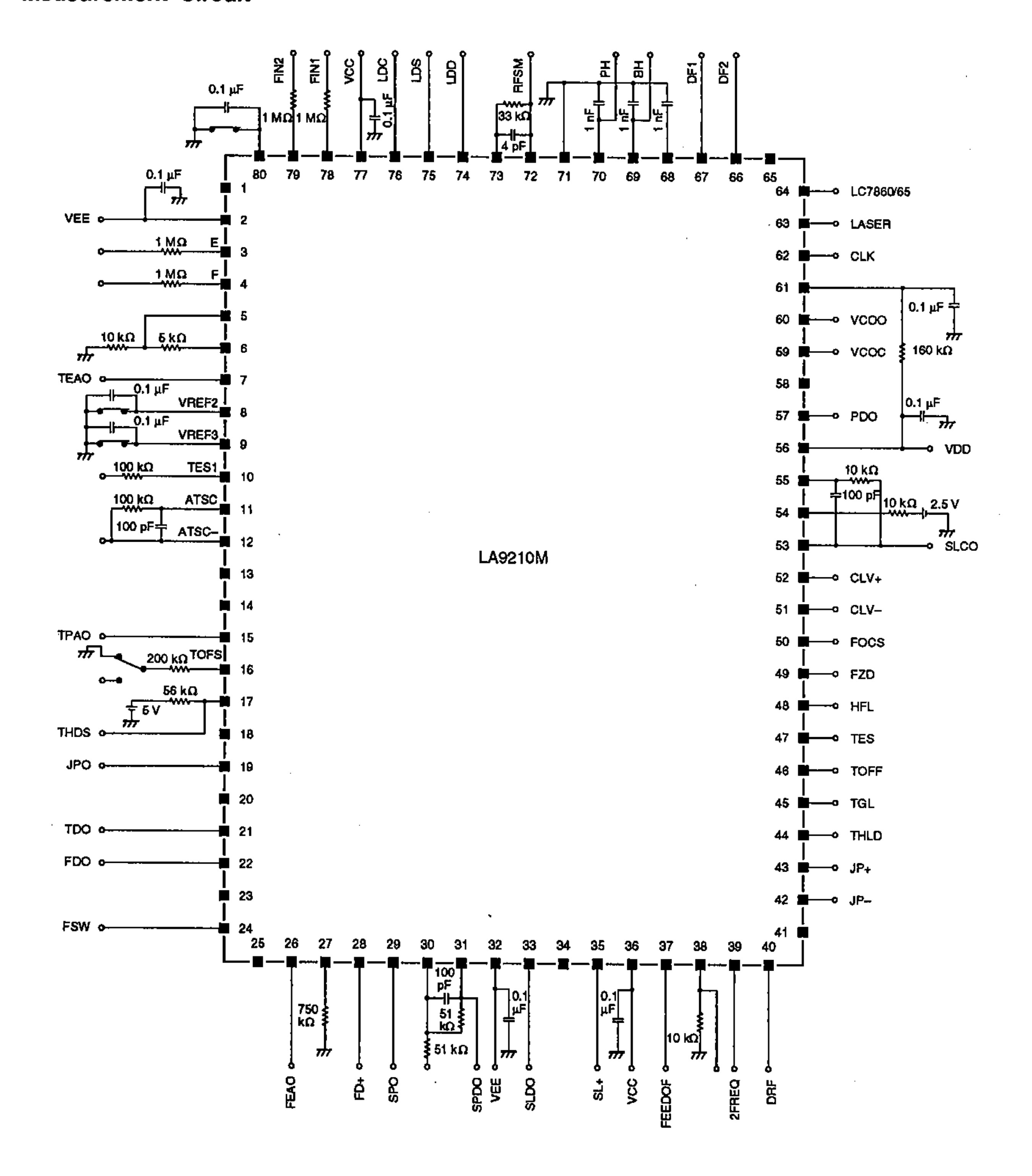
| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Output voltage | $V_{VCO1(O)}$ | $V_{LC7860/65}$ = 5 V, $f_{CLK}$ = 2.1609 MHZ, $V_{2FREQ}$ = 5 V, 160 kΩ resistor between LF1 and 5 V | 0.5 | 2.0 | 4.0 | $V_{p\text{-}p}$ |
| | $V_{VCO2(O)}$ | $V_{LC7860/65}$ = 5 V, $f_{CLK}$ = 2.1609 MHz, $V_{2FREQ}$ = 0 V, 160 kΩ resistor between LF1 and 5 V | 0.5 | 2.0 | 4.0 | $V_{p\text{-}p}$ |

## Reference voltage

$V_{CC}$ = 5 V, $V_{DD}$ = 5 V, $V_{EE}$ = –5 V, $T_a$ = 25 °C, $V_{REF1}$ = $V_{REF2}$ = $V_{REF3}$ = 0 V unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| VREF1 reference voltage | $V_{REF1}$ | Measured at VREF1 with VREF1 open | –3.55 | –3.30 | –3.05 | V |
| VREF3 reference voltage | $V_{REF3}$ | Measured at VREF3 with VREF2 and VREF3 open | –0.15 | 0 | 0.15 | V |

## Measurement Circuit



## Typical Performance Characteristics

### Power dissipation vs. ambient temperature

